Space Weather Technical Forecast

Issued on Tuesday, 25 January 2022 at 00:44 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

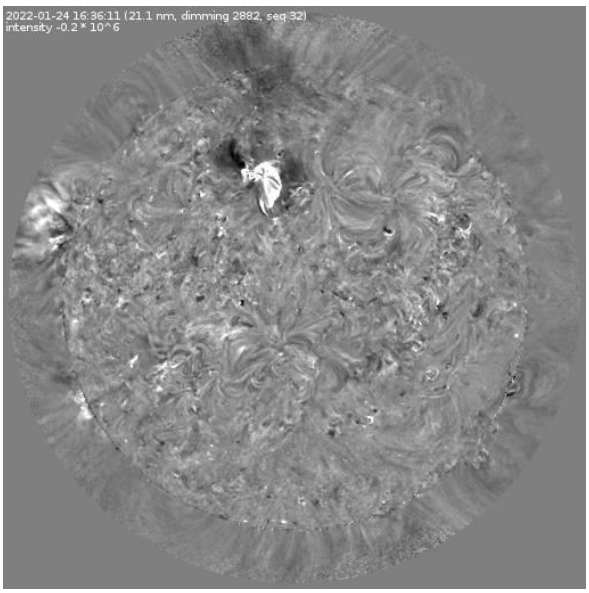
Space Weather Forecast Headline: Small but sustained likelihood of G1 Minor Geomagnetic storms. Active electron fluence continuation becoming less likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with peak activity being a C1.1-flare observed at 24/0237UTC from a new sunspot region that has recently rotated over the northeast limb as a Cro/Beta. This is one of up to three sunspot regions on the current disc, adding to the long-term resident and inactive AR2934, which remained an Hsx/Alpha, and another spot which developed in the northern solar hemisphere near the solar meridian, given the number AR2935 and reaching Bxo/Beta complexity in the period.

There were several minor coronal dimmings evident from various locations across the northern solar hemisphere in the period. Possibly the most noteworthy of these - for being both the largest and most central - occurred at 24/1530UTC from the vicinity of the newly-developed AR2935. At the time of writing, no Earth-directed Coronal Mass Ejections (CMEs) were observed in available imagery, however this is being monitored.

Figure 0: Solar Demon AIA 211 time integrated view of the most notable of the northern hemisphere dimmings in the period – from slightly north of new region AR2935. This event has not produced definitive ejecta visible on coronagraphs at the time of writing, however this is being monitored. Image processing courtesy of SIDC ROB.



Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, initially typified a slow solar wind regime, but there were increasingly signs of enhancement as the period went on. The cause of this is uncertain, however it is perhaps most likely to be a CIR

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ahead of a coronal hole, probably CH46.

Accordingly, the solar wind density rose significantly through the UTC day, starting in single figures ppcc, but increasing to a peak of around 30ppcc before falling back a little into the UTC evening. The IMF also showed a rise, from background levels to peak at 11nT in the final hours of the period, with a north-south range between +/-6nT. The solar wind speed was less noteworthy, ranging between 325 and 290km/s throughout. The phi angle was mostly negative (towards the sun) but underwent a deviation into positive for a time around the UTC dawn.

The result of the above solar wind measures was for provisionally Quiet Kp throughout the 24 hours, peaking at 2o in the 21-24UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2MeV), was mainly at High levels, with a peak value of 1.0e4pfu at 24/1545UTC. Electron fluence persisted above the 1e8 Active threshold throughout, with a slight rising trend, with fluence at 25/0000UTC measured at 2.99e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low to Very Low, with up to three small and simple sunspots on the Earth-facing side of the disc, giving a daily 25% Chance of further C-class flares.

Solar Wind / Geomagnetic Activity: There are up to three glancing CME arrivals possible in the forecast period through to and including midweek UTC, although two of these are now overdue and may have passed 1AU to no effect. The fast wind of CH46 is also expected to arrive, most probably on day one (Tuesday 25 January) but with some notable uncertainty.

Until the arrival of this fast wind or any CMEs, background slow wind conditions will ensure Quiet geomagnetic activity. Any enhancements will bring a risk of Active intervals, with a Chance of G1/Minor Geomagnetic storms. At the end of the four days, a second coronal hole may become geoeffective, giving a further peak Slight Chance of G1.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at Background levels.

The high energy electron flux (greater than 2MeV) is expected to continue to reach High flux levels at first, however a drop out in values is then likely from the arrival of the fast wind of CH46 and any of the glancing incidence CMEs. The 24-hour fluence is forecast to persist above the Active (1e8 integrated pfu) threshold initially, but likely dropping below the Active threshold after midweek in the less supportive environment expected in the wake of any geomagnetic activity. A second peak in fluence may occur following a coronal hole due later in the working week - CH47, perhaps from Thursday 28 January.

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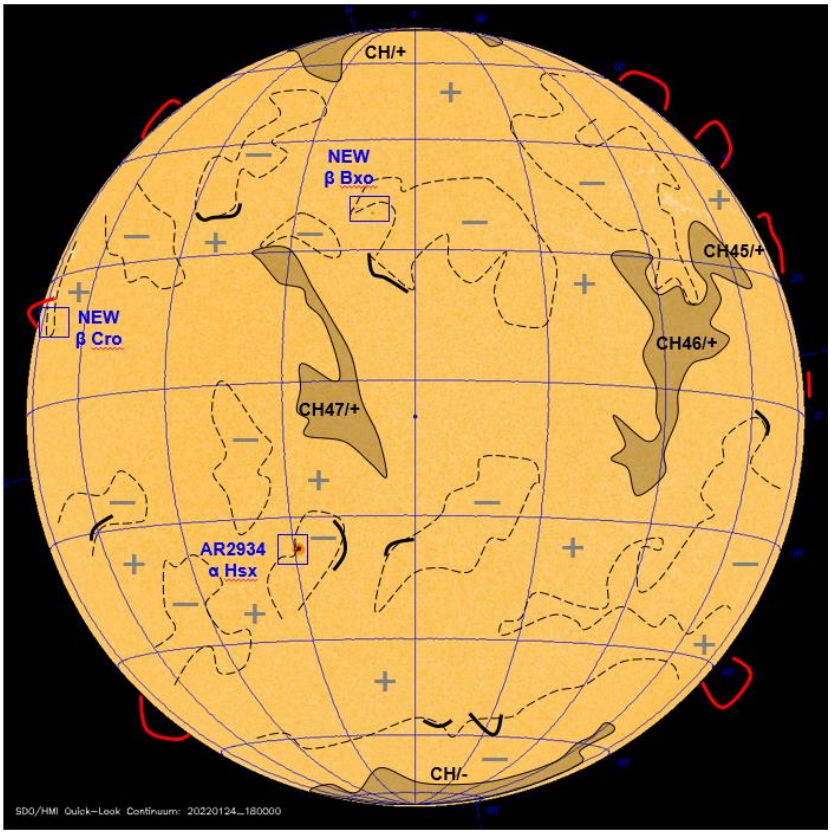
Figure 1. Solar Analysis Valid 24/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are several CMEs that may glance Earth in the forecast period, with forecast arrivals up to and including the middle of the UTC week.

Two potential CMEs with Earth-bound components are now overdue and may have passed 1AU to no effect at Earth. There remains a small chance that these arrive early on day one (Tuesday 25 January), however effects should be suitably attenuated, and the risk of G1 from these is therefore lower than previously stated (but more than compensated for by a host of other features). This leaves one main CME in the forecast: a filament lift-off from 22 January that has been modelled and shows a possible glance late on 25 or into 26 January.

The fact that two overdue CMEs and a possible third all carry a risk of arriving within day one, as well as the expected onset of CH46 falling within this 24-hour period, all combine to give a peak Chance of G1 on Tuesday 25 January, probably lasting into day two as a Slight Chance given the CME risk straddling these days. A lull should then follow by the UTC day of Thursday, ahead of a possible second high speed stream arrival on Friday 28 giving a further Slight Chance of G1.

All said, it should be noted that given the number CME features, and the uncertainty around the coronal hole arrival times, confidence in this forecast period is low.

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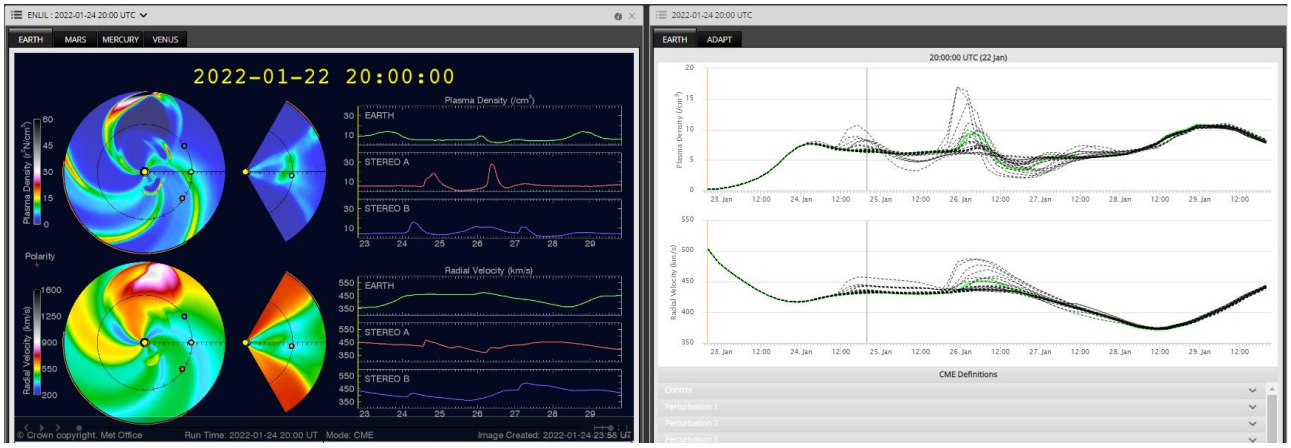
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	20	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/1642	Partial	Filament	S02 W059	478	24/1200UTC, overdue	Possible miss
21/0900	Partial	Filament	S23 E061	601	24/1200UTC	Possible miss
22/0630	Partial	Filament	N15 E020	400	26/0001UTC	Possibkle glance

Figure 2: MOSWOC 24/2000UTC Enlil run and ensemble. The perturbations valid for the very start of the simuilation are linked with the CMEs that left the sun on 20 and 21 January and are now overdue. Should they arrive, they are relatively less liekly to be impactful for being slower or of more glancing incidence than forecast. The more assured glance from the filament that left on 22 Janaury features between the first two days of the forecast period, overlying the more assured increase from CH46. CH47 then rounds out the coming four-day period with a modest increase, perhaps underdone on recent STEREO A evidence.



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Radio Blackouts - X-Ray Flares:

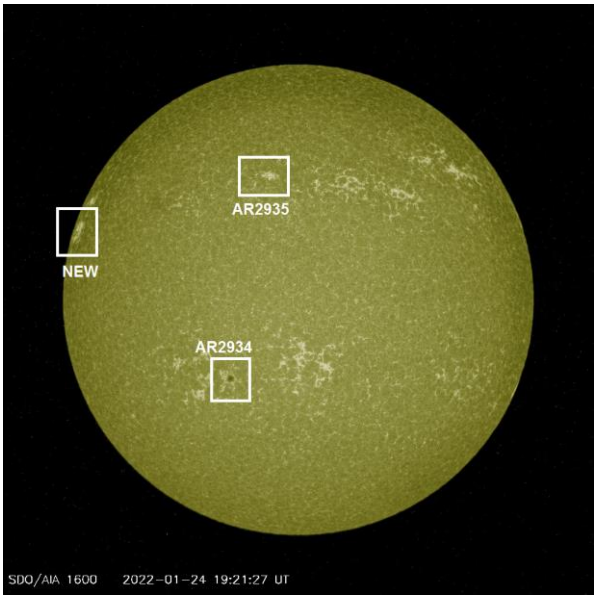
There are now up to three sunspot regions on the Earth-facing disc. In addition to the long-term resident and inactive AR2934, which remains an Hsx/Alpha, a new group was numbered AR2935 in the northern solar hemisphere near the meridian, eventually developing Bxo/Beta classification. In addition to these numbered regions, a newly-developed group lay on the eastern solar horizon, with the narrow viewing angle hampering analysis, however it appears to manifest as a Cro/Beta at present.

None of these groups has so far proved particularly noteworthy in terms of activity, and the risk of flares is maintained at a daily 1% chance of M-class, however the chances of C-class flares have increased to 25%.

In terms of the balance of groups, none are due to leave the disc in the period, while STEREO A EUVI imagery suggests a possible return for Ex-2924 and perhaps Ex-2926 to end this working week. Any assessment as to these possible returning groups' contribution to flare risk is reserved until they present for analysis.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	1	1	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: AIA 1600 from 24/1900UTC, showing sunspot regions on the Earth-facing side and their surrounding plage areas. The region labelled 'NEW' is likely to reveal further detail in the coming hours.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. No solar radiation storms are expected in the period, with only a few simple and inactive sunspots on the Earth-facing side of the Sun.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux, as measured by GOES-16 at GEO, has recently run counter to expectations and has shown a slight rising trend in the absence of any reset from geomagnetic activity from either CMEs or coronal holes. This state of affairs is still felt unlikely to last, especially given that a reasonably assured coronal hole high speed stream from CH46 is now due.

Active electron fluence is expected to continue in the immediate term, but should soon be curtailed for a period under potential attack from CH46 and any CMEs. After a lull, some degree of recovery is likely, but probably not to the levels currently seen. Of lower confidence is the reaction to a second high speed stream, with STEREO A PLASTIC data currently seeing a noisy trace but with some data points in excess of 750km/s. Should this occur later this working week, a sharper upward response may show at GOES 16 high energy electrons, although confidence in this aspect is currently low. There is therefore a twin peak in risk of Active fluence - both early and late in the working week, with confidence suitably lower in the latter given the range.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	60	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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